

### Titles

Amateurs Triumph in Paris, *Stephen James O'Meara*, 480  
 America in Space: Where Next? *Leonard David*, 23  
 B Stars, The: Beacons of the Skies, *James B. Kaler*, 147  
 Charting the Southern Sky, *John Lankford*, 243  
 Discovering M31's Spiral Shape, *Gérard de Vaucouleurs*, 595  
 Gamma-Ray Pinhole Camera, *A. Walter J. Wild*, 126  
 GONG: To See Inside Our Sun, *John W. Harvey*, *James R. Kennedy*, and *John W. Leibacher*, 470  
 Gravity Waves: A Progress Report, *Virginia Trimble*, 364  
 High-Flying Kvant Module, The, *J. Kelly Beatty*, 599  
 In the Shadow of the Horsehead, *David Malin*, 253  
 Laying Bare Venus' Dark Secrets, *David A. Allen*, 350  
 Legacy of E. E. Barnard, *George S. Mumford*, 30

Mysterious Woodcut, *A. David W. Hughes*, 252  
 Newton's Principia: A Retrospective, *Gale E. Christianson*, 18  
 Observing with the CAT, *George H. East*, 484  
 Particle Physics for Everybody, *Paul Davies*, 582  
 Perfecting the Modern Reflector, *William Tobin*, 358  
 Pluto and Charon: The Dance Goes On, *J. Kelly Beatty*, 248  
 Popular Astronomy Handbook, facing 280  
 Six-Meter Views of M33, *David H. Smith*, 140  
 Sky on a Chip: The Fabulous CCD, *James Janesick* and *Morley Blouke*, 238  
 SN 1987A: Watching and Waiting, *Ronald A. Schorn*, 14  
 Solar-Stellar Connection, The, *Mark S. Giampapa*, 142  
 Spectacular O Stars, The, *James B. Kaler*, 464

Spirals from Order and Chaos, *David H. Smith*, 136  
 Stellar Granulation, *Ronald A. Schorn*, 247  
 Strange Case of Beta Lyrae, The, *Jocelyn Tomkin* and *David L. Lambert*, 354  
 Supernova 1987A after 200 Days, *Ronald A. Schorn*, 477  
 Supernova 1987A's Fading Glory, *Ronald A. Schorn*, 258  
 Surveying the Northern Sky, *James Schombert*, 128  
 Top 10 Telescope Ideas of 1987, The, 590  
 Total Solar Eclipse of March, 1988, The, *Edward M. Brooks*, 21  
 VB 8B's Vanishing Act, *Ronald A. Schorn*, 139  
 Wandering Stars of Allegheny, The, *Roger W. Sinnott*, 360  
 White Dwarfs: Fossil Stars, *Steven D. Kawaler* and *Donald E. Winget*, 132

### Authors

*Abt, Helmut A.*, letter, 599  
*Allen, David A.*, Laying Bare Venus' Dark Secrets, 350  
*A. M.*, see *MacRobert, Alan*  
*Anderson, Jay*, Weather and Sites, 22  
*Arbour, Ron*, A Camera That Tracks Comets, 428  
*Balbi, Luigi*, A Wire Micrometer for Photographs, 310  
*Beatty, J. Kelly*, Pluto and Charon: The Dance Goes On, 248  
 The High-Flying Kvant Module, 599  
 The Pride of Globe, Arizona, 192  
 Who the Heck Are You, Anyway? 572  
*Bethune, Robert W.*, letter, 230  
*Blouke, Morley*, see *Janesick, James*  
*Bortle, John E.*, Comet Digest, 108, 217, 329, 442, 562, 681  
*Brooks, Edward M.*, The Total Solar Eclipse of March, 1988, 21  
*Brown, Stanley G.*, letter, 453  
*Burnett, Gregory A.*, letter, 6  
*Byrd, Deborah*, The Sun, Moon, and Planets This Month, 58, 170, 282, 394, 510, 632  
*Christianson, Gale E.*, Newton's Principia: A Retrospective, 18  
*Clapp, Doug*, A Portable Observatory You Say? 87  
*Colgate, Stirling*, letter, 229  
*Coyle, Harold P.*, Astronomy Texts from Abell to Zeilik, 487  
*Crist, Michael*, letter, 574  
*David, Leonard*, America in Space: Where Next? 23  
*Davies, Paul*, book review, 609  
 Particle Physics for Everybody, 582  
*Dawes, Ron*, letter, 453  
*de Vaucouleurs, Gérard*, Discovering M31's Spiral Shape, 595  
*di Cicco, Dennis*, April's Occultation of Venus, 214  
 Skyshooting with the Fastest Color Film, 558  
*Dobbins, Thomas A.*, see *Parker, Donald C.*  
*Drake, Frank D.*, book review, 39  
*Dunham, David W.*, A Grand Pleiades Occultation, 284  
*Dunham, Robert S.*, letter, 573  
*East, George H.*, Observing with the CAT, 484  
*Emry, Murishka K.*, letter, 230  
*Evans, Robert*, book review, 375  
*Falworth, Geoffrey*, letter, 342  
*Fienberg, Richard Tresch*, After Challenger: Astronomical Angst, 29  
*Fleet, Richard*, letter, 342  
*Giampapa, Mark S.*, The Solar-Stellar Connection, 142  
*Gingerich, Owen*, book review, 152  
 letter, 6  
*Greaney, Michael P.*, The Orbit of a Binary Star, 71

*Green, Daniel W. E.*, What To Do If You Discover a Comet, 420  
*Green, Darrell W.*, A Night on Historic Mount Wilson, 438  
*Halbach, Edward A.*, Halbach's "Astroflash," 90  
*Harbour, David A.*, Experiments with a Toothless Sector, 546  
*Harris, Joel K.*, letter, 342  
*Harrison, Edward*, book review, 262  
*Harvey, John W.*, *James R. Kennedy*, and *John W. Leibacher*, GONG: To See Inside Our Sun, 470  
*Hazen, Martha L.*, book review, 374  
*Henbest, Nigel*, Amateurs, Professionals Unite in England, 536  
*Henshaw, Colin*, letter, 342  
*Hoag, Arthur A.*, book review, 373  
*Hoffman, Tony*, letter, 6  
*Houston, Walter Scott*, Deep-Sky Wonders, 106, 219, 331, 443, 682  
*Huchra, John*, book review, 610  
*Hughes, David W.*, A Mysterious Woodcut, 252  
*Hunter, Tim B.*, Improving Astrophotos by Copying, 326  
*Janesick, James*, and *Morley Blouke*, Sky on a Chip: The Fabulous CCD, 238  
*Jones, Jonathan Spencer*, letter, 117  
*Kaler, James B.*, The B Stars: Beacons of the Skies, 147  
 The Spectacular O Stars, 464  
*Kawaler, Steven D.*, and *Donald E. Winget*, White Dwarfs: Fossil Stars, 132  
*Kemble, Fr. Lucian J.*, OFM, letter, 453  
*Kennedy, James R.*, see *Harvey, John W.*  
*Koolish, Richard M.*, Thermopak -- Heat at the Press of a Button, 602  
*Kremers, Adam*, Regulating the Voltage of a DC Motor, 198  
*Lambert, David L.*, see *Tomkin, Jocelyn*  
*Lankford, John*, Charting the Southern Sky, 243  
*Larr, Eugene C.*, A Motorized Observing Chair, 665  
*Laurent, Dirk*, see *Roggemans, Paul*  
*Leibacher, John W.*, see *Harvey, John W.*  
*Liller, William*, A Boatbuilder's Dome in Chile, 664  
*Lindley, David*, book review, 611  
*Louçon, Jim*, Let's Save Mars First, 228  
*Lovi, George*, Rambling Through the Skies, 55, 167, 279, 391, 507, 625  
*MacRobert, Alan*, A Daytime Occultation of Spica, 174  
 Jupiter's Great Red Spot, 513  
 The "Great Black Lake" of Plato, 396  
 The Librations of the Moon, 60  
 Two Short-Period Variables, 398  
*Maddux, William S.*, Sundials on Walls, 646

*Maley, Paul D.*, A One-Second Total Eclipse, 102  
*Malin, David*, In the Shadow of the Horsehead, 253  
*Marshall, Laurence A.*, book review, 41  
*Mattei, Janet Akyuz*, Variable Star Day at Leiden, 535  
*Meketa, James E.*, Viewing Libration with the Naked Eye, 63  
*Minanel, Shelley*, letter, 6  
*Morris, Michael*, letter, 574  
*Mosley, John*, Review Corner, 73, 296, 529  
*Mulford, Robert A.*, Fun With Stereographic Projections, 407  
*Muller, Richard A.*, and *Carlton R. Pennypacker*, letter, 230  
*Mullis, Christopher R.*, letter, 118  
*Mumford, George S.*, The Legacy of E. E. Barnard, 30  
*Nicholson, James H.*, To Catch a Child's Imagination, 303  
*Olson, Donald W.*, The Tide at Tarawa, 526  
*O'Meara, Stephen J.*, Amateurs Triumph in Paris, 480  
 The Children of Stellafane, 417  
*Page, Thornton*, book review, 373  
*Palumbo, G. G. C.*, and *R. Serra*, Astronomy for the Italian Public, 656  
*Parker, Donald C.*, and *Thomas A. Dobbins*, The Art of Planetary Observing -- I, 370; II, 603  
*Pennypacker, Carlton R.*, see *Muller, Richard A.*  
*Petersen, Carolyn Collins*, book review, 153  
*Powers, William T.*, letter, 229  
*Preston, Sandra*, Astronomy under Texas Skies, 81  
*Rasmussen, Ralph*, letter, 342  
*Rast, Richard H.*, letter, 118  
*Raymo, Chet*, A "Yes" for the French Space Ring, 5  
 book reviews, 262, 608  
*Rehnlund, Sven O.*, A Homemade Wide-Angle Eyepiece, 424  
*Robinson, Leif J.*, Antoinette de Vaucouleurs, 598  
*Roggemans, Paul*, *Dirk Laurent*, and *Christian Steyaert*, The Ursid Meteor Stream, 678  
*R. W. S.*, see *Sinnott, Roger W.*  
*Sadler, Philip M.*, Secret Weapon: Astronomy, 452  
*Sagan, Carl*, Why Star Wars Is Bad for Astronomy, 340  
*Schalck, Robert E.*, letter, 118  
*Schombert, James*, Surveying the Northern Sky, 128  
*Schorn, Ronald A.*, SN 1987A: Watching and Waiting, 14  
 Stellar Granulation, 247  
 Supernova 1987A After 200 Days, 477  
 Supernova 1987A and the Press, 116  
 Supernova 1987A's Fading Glory, 258  
 VB 8B's Vanishing Act, 139  
*Schramm, D. N.*, Why Astronomers Need the SSC, 588  
*Schweizer, Linda Y.*, book review, 261

Serra, R., see Palumbo, G. G. C.  
 Sinnott, Roger W., Stars and Spikes, 294  
 The Wandering Stars of Allegheny, 360  
 S. J. O., see O'Meara, Stephen James  
 Smith, David H., book review, 44  
 Six-Meter Views of M33, 140  
 Spirals from Order and Chaos, 136  
 The Birth of Stellar Seismology, 475  
 Smith, Harlan J., Astronomy from the Moon, 27  
 book review, 151  
 Stangl, Martin, letter, 454  
 Steyaert, Christian, see Roggemans, Paul  
 Stiles, Phillip J., see Wagner, Andrew

Thomsen, Dietrich E., book review, 261  
 Tifft, William G., letter, 454  
 Tobin, William, Perfecting the Modern Reflector, 358  
 Tomkin, Jocelyn, and David L. Lambert, The Strange  
 Case of Beta Lyrae, 354  
 Trimble, Virginia, book review, 260  
 Gravity Waves: A Progress Report, 364  
 Troit, Dave, Possibilities of a "Tetrapod," 426  
 Valletti, Paul A., letter, 573  
 van den Bergh, Sidney, Century 21: The Age of Space  
 Junk? 4  
 Vanhoec, Luc, Progress and Panic at Puimichel, 543  
 Vaughan, Robert, letter, 342

Wagman, Morton, letter, 117  
 Wagner, Andrew, and Phillip J. Stiles, How To  
 "Steady" a Rooftop Telescope, 314  
 Weitzenhoffer, Kenneth, letter, 574  
 West, John E., letter, 117  
 Westfall, John E., Timing Eclipses of Jupiter's  
 Moons, 634  
 Wharton, John, letter, 118  
 Wild, Walter J., A Gamma-Ray Pinhole Camera, 126  
 Wingate, Bruce, A Garage-Roof Observatory, 202  
 Winget, Donald E., see Kawaler, Steven D.  
 Worden, Simon P., Why Astronomers Should Love  
 SDI, 340

## Departments and Features

### Amateur Astronomers —

Amateurs, Professionals Unite in England, 536  
 Amateurs To Get RGO Telescopes? 537  
 Astronomy for the Italian Public, 656  
 Astronomy under Texas Skies, 81  
 Calendar of Events, 305  
 Children of Stellafane, The, 417  
 International News, 84, 194, 658  
 Pride of Globe, Arizona, The, 192  
 Sample Telegram, A, 421  
 Stonehenge in Missouri, 83  
 To Catch a Child's Imagination, 303  
 Variable Star Day at Leiden, 535  
 What To Do If You Discover a Comet, 420

### Astronomical Computing —

Bits and Bytes, 183  
 Do Orbits Change in 100 Million Years? 182  
 Fun with Stereographic Projections, 407  
 Measuring a Wall's Azimuth, 648  
 Orbit of a Binary Star, 71  
 Review Corner, 73, 296, 529  
 Stars and Spikes, 294  
 Sundials on Walls, 646  
 Tide at Tarawa, The, 526

### Backyard Astronomy —

Art of Planetary Observing, The — I, 370; II, 603  
 Case Study, A: How To Draw Mars, 605  
 Observing from the City, 35 (correction, 230)

### Books and the Sky —

Astronomical Observations: An Optical Perspective,  
 Gordon Walker, 610  
 Astronomy Texts from Abell to Zeilik, 487  
 Birth of the Earth, The, David E. Fisher, 373  
 Briefly Noted, 45, 154, 263, 376, 493, 612  
 Cosmology: The Structure and Evolution of the  
 Universe, G. Contopoulos and D. Kotsakis, 260  
 Exploring the Southern Sky, Sven Laustsen, Claus  
 Madsen, and Richard M. West, 608  
 James Lick's Monument, Helen Wright, 373  
 Joshua Factor, The, Donald D. Clayton, 44  
 Left Hand of Creation, The, John D. Barrow and  
 Joseph Silk, 611  
 Light from the Depths of Time, Rudolf Kippen-  
 hahn, 262  
 Mind-Boggling Universe, The, Neil McAleer, 262  
 My Daughter Beatrice: A Personal Memoir of Dr.  
 Beatrice Tinsley, Astronomer, Edward Hill, 261  
 1987 S&T Guide to Introductory Astronomy Texts,  
 The, 488  
 Particle Explosion, The, Frank Close, Michael Mar-  
 ten, and Christine Sutton, 609  
 Practical Astronomy, David H. DeVorkin, 152  
 Quasar Astronomy, Daniel W. Weedman, 151  
 Search for Extraterrestrial Intelligence, The,  
 Thomas R. McDonough, 39  
 Study of Variable Stars Using Small Telescopes,  
 The, John R. Percy, 374  
 Thursday's Universe, Marcia Bartusiak, 261  
 Universe . . . and Beyond, The, Terence Dickinson,  
 41  
 Variable Stars, Michel Petit, 374  
 Webb Society Deep-Sky Observer's Handbook, Vol.  
 6: Anonymous Galaxies; Vol. 7: The Southern  
 Sky, Kenneth Glyn Jones, editor, 375  
 Your Future in Space: The U. S. Space Camp  
 Training Program, Flip Schulke, Debra Schulke,  
 Penelope McPhee and Raymond McPhee, 153

### Celestial Calendar —

Appulse of Asteroids, An, 172  
 Binocular Hyades Variable, A, 512  
 Calendar Notes, 64, 174, 287, 400, 515, 636  
 Daytime Occultation of Spica, A, 174  
 Deep Penumbral Eclipse of the Moon, A, 399  
 Far-Eastern Annular Eclipse, A, 172  
 Grand-Pleiades Occultation, A, 284  
 "Great Black Lake" of Plato, The, 396  
 Hyades-Crossing Asteroid, A, 637

Jupiter's Great Red Spot, 513  
 Jupiter's Satellites, 58, 170, 282, 394, 513, 632  
 Librations of the Moon, The, 60  
 Mira Brightening, 636  
 Moonwatcher's Corner, 60, 175, 286, 398, 515, 637  
 Sun, Moon, and Planets This Month, The, 58, 170,  
 282, 394, 510, 632  
 Timing Eclipses of Jupiter's Moons, 634  
 Two Short-Period Variables, 398  
 Upcoming Eclipses, 635  
 Venus in the Evening Sky, 514  
 Viewing Libration with the Naked Eye, 63  
 50 and 25 Years Ago, 6, 118, 230, 357, 454, 574

### Focal Point —

Century 21: The Age of Space Junk? 4  
 Let's Save Mars First, 228  
 Secret Weapon: Astronomy, 452  
 Supernova 1987A and the Press, 116  
 Who the Heck Are You, Anyway? 572  
 Why Astronomers Should Love SDI, 340  
 Why Star Wars Is Bad for Astronomy, 340  
 "Yes" for the French Space Ring, A, 5

### Front-cover photographs —

Earthbound, I  
 Make-believe Astronaut, 113  
 Orion's Dark Horse, 225  
 Planet Catcher, 337  
 Ringing Sun, The, 449  
 Simulating the Big Bang, 569

### Gleanings for ATM's —

Boatbuilder's Dome in Chile, A, 664  
 Camera That Tracks Comets, A, 428  
 Experiments with a Toothless Sector, 546  
 Garage-Roof Observatory, A, 202  
 Halbach's "Astroflash," 90  
 Homemade Wide-Angle Eyepiece, A, 424  
 How To "Steady" a Rooftop Telescope, 314  
 Motorized Observing Chair, A, 665  
 Optical Bench Talk, 317, 548, 667  
 Portable Observatory You Say?, A, 87  
 Possibilities of a "Tetrapod," 426  
 Progress and Panic at Puimichel, 543  
 Regulating the Voltage of a DC Motor, 198  
 Wire Micrometer for Photographs, A, 310

### Images, 16

Letters, 6, 117, 229, 342, 453, 573

### News Notes —

Aging of Primordial Hydrogen Clouds, 235  
 Alan Moffet, 1936-87, 576  
 American-Soviet Space Pact, 11  
 Astronomy Express, 13, 125, 237, 349, 463, 581  
 At the Diffraction Limit, 236  
 Bengt Stromgren, 1908-87, 348  
 Big Splash in the Pacific, A, 12  
 Bloated Stars in Quasars? 457  
 Case for Mars III, 7  
 Chewing on Gomez's Hamburger, 462  
 Comet-Asteroid Connection, The, 343  
 Countdown to Ulysses, 347  
 Curious Cluster, 345  
 Deuterium, Dust, and Infant Stars, 236  
 Educating for Space, 231  
 Everest Topped, 121  
 Extragalactic Gamma-Ray Bursters? 9  
 Faint Stars and Brown Dwarfs, 461  
 "First Light," 348  
 Frosty the . . . Nebula? 346  
 Globular Clusters in the Coma Cluster of Galaxies,  
 346  
 Goodbye Olbers' Paradox! 458  
 Great Attractor, The, 119  
 Heating the Sun's Corona: Still a Mystery? 231  
 Hexagonal Galaxy, 120  
 Hole at the Heart of Andromeda, A, 10  
 Hotter Earth's Core, A, 345  
 How Many Stars Are Binary? 8  
 HST's Power Struggle: An Update, 7

Hunting for the Heliosphere, 578  
 Indian Telescope Projects, 12  
 Infrared Telescopes Take to the Road, 575  
 Interstellar Ooze? 233  
 IRAS Unveils the Cygnus Loop, 233  
 Keck Observatory Takes Shape, 575  
 Lambda Orionis' Molecular Ring, 455  
 La Palma's Giant Telescope, 458  
 Largest Galaxy, The, 9  
 Lofty Millimeter Telescope, 120  
 Mauna Kea Wins the NNTT, 8  
 Methanol Masers, 119  
 Michael Ovenden Dead, 234  
 More on Noctilucent Clouds, 7  
 New Amateur Radio Astronomy Journal, 580  
 New Detector Captures Uranus' Rings, 231  
 New Evidence Unearthed at Tunguska Site, 459  
 New Light on Auroras, A, 344  
 New Light on Cassiopeia, A, 124  
 New Views of Neptune, 235  
 NGC 4013's Warped Hydrogen Disk, 576  
 100 Trillion Clouds, 121  
 Oori Cloud Comets: Blasted, Bumped, and Baked?  
 459  
 Pinpointing Near-Earth Asteroids, 576  
 Pioneer 9 Lost, 7  
 Planetary Probes Double as Space Telescopes, 456  
 Polar-Ring Galaxies, 459  
 Pulsar Sets New Record, 231  
 Quasars in the Making? 577  
 Quasars: The Movie, 457  
 Radar Can Find Antarctic Meteorites, 10  
 Satellite Storage, 11  
 Satellite To Search for Relativity Proof, 460  
 Satellite Trackers Bag Soviet Space Station, 580  
 Scum on Triton's Seas? 462  
 Solar Systems in the Orion Nebula? 348  
 Star-Forming Globule, 461  
 Still No Asteroid Satellites, 455  
 Strange Stars Don't Glitch, 580  
 Sun's Hidden Magnetism, The, 343  
 Supernovae: How Often? 460  
 Supernova Prologue, 234  
 Teaching Astronomy, 8  
 Trillion-Dollar Asteroids? 11  
 Twisters on the Red Planet? 579  
 What's in the Bootes Void? 232  
 When the Sun Swallows the Earth, 575  
 White Dwarfs and the Age of the Universe, 347  
 Young Dwarf Galaxy . . . And a Giant, A, 122, 123  
 Young Virgo Cluster?, The, 578

### Observer's Page —

April's Occultation of Venus, 214  
 Celestial Sea, The, 625  
 Bidding the Day Adieu, 680  
 Comet Digest, 108, 217, 329, 442, 562, 681  
 Counting Meteors, 678  
 Deep-sky Wonders, 106, 219, 331, 443, 682  
 Improving Astrophotos by Copying, 326  
 Night on Historic Mount Wilson, A, 438  
 One-Second Total Eclipse, A, 102  
 Skyshooting with the Fastest Color Film, 558  
 Sunspot Numbers, 107, 221, 333, 445, 563, 683  
 Ursid Meteor Stream, The, 678

### Rambling Through the Skies —

Celestial Sea, The, 625  
 Early Star Mapper, An, 391  
 Invitation to Imbrium, 55  
 Milky Way Meanderings, 167  
 Soccer-Ball Sky, The, 279  
 Zodiacal Signs vs. Constellations, 507

### S&T Test Report —

Observing with the CAT, 484  
 Thermopak — Heat at the Press of a Button, 602  
 Southern Stars for . . . (current months), 54, 278, 506  
 Stars for . . . (current month), 56, 168, 280, 392, 508,  
 626

# Selected Topics and Celestial Objects

This listing is not intended to be exhaustive and does not supplant the other parts of the index. For example, material in such regular features as Books and the Sky is ordinarily indexed only under the Departments and Features section.

- Amateur activities:** award winners, 483; British meet with professionals, 536; children at Stellafane, 417; conference in Paris, 480; high-school programs, 192; homemade star maps, 194; in India, 84, 659; in Ireland, 658; in Italy, 656; IUA failure, 482; with Kuiper Airborne Observatory, 303; at McDonald Observatory, 81; meteor observations, 658; students for space, 658; variable star observers, 84, 535
- Art:** of Paul DiMare, 23, 24; of Carter Emmart, 25; of Robert McCall, 26; meteor woodcut, 252; of Ron Miller, 25; of Adolf Schaller, 41
- Asteroids (minor planets):** Astraea crosses M44, 109; Hebe-Iris appulse, 172; metal-rich, 11; pinpointing near-Earths, 576; as planetary satellites, 349; satellites of, 455; similarities to comets, 343
- Astrometry:** at Allegheny Observatory, 360; near-Earth asteroids, 576; of the southern sky, 243; wire micrometer for, 310
- Atlases and catalogues:** new Palomar sky survey, 128; of photographic meteors, 184; southern sky from European Southern Observatory, 608; stars on floppy disk, 183; stereographic projection, 407
- Atmospheric phenomena:** noctilucent clouds, 7; seeing effects of contrails, 6
- Auroras:** cause of, 344
- Bioastronomy:** amino acids in meteorites, 233; phosphorus in space, 463; SETI, 39
- Black holes:** see *Collapsed objects*
- Celestial mechanics:** long-term integration, 182; 17th-century methods, 6
- Chemistry:** amino acids in meteorites, 233; deuterium abundance, 236; hydrocarbons in Comet Halley, 13; phosphorus in space, 463; polymer in Comet Halley, 349; Triton's surface, 462
- Collapsed objects:** black holes in M87, 13; fastest pulsar, 231; first pulsar in globular cluster, 125; formation of supermassive black holes, 457; in galactic center, 349; millisecond pulsar in M28, 125; pulsar in M4, 581; stars made of strange matter, 580; supermassive black hole in M31, 10; white dwarfs, 132, 147, 347
- Comet Halley:** 108, 430; hydrocarbons in, 13; polymer in, 349; school shuttle experiment, 303
- Comets (see also Comet Halley):** Borrelly, 108, 217, 329, 442, 562, 681; Bradfield (1987s), 442, 562, 681; Brooks 2, 217, 329, 442; Denning-Fujikawa, 108, 217; Encke, 217, 329; Grigg-Skjellerup, 108, 217; IRAS-Araki-Alcock (1983d), 430; Klemola, 108, 217, 329, 442; Levy (1987y), 681; as meteor shower parent, 237; Mrkos (1957V), 329; Nishikawa-Takamizawa-Tago (1987e), 108, 237; Oort-cloud evolution, 459; origin of CHON, 6; record number of, 681; reporting a discovery, 420; Rudenko (1987u), 442, 562, 681; Schwassmann-Wachmann 1, 217; Shoemaker (1987z), 681; similarities to asteroids, 343; Sorrells (1986n), 108, 217; top comet hunters, 442; tracking camera for, 428; Wilson (1986i), 108, 217, 442
- Computing:** binary star's orbit, 71; changes in planetary orbits over time, 182; diffraction effects, 294; geosynchronous satellites, 184; modeling black hole formation, 457; stereographic projections, 407; sundials, 646; tides and lunar apogee, 526
- Constellation study:** Peter Apian's charts, 391; Arabic asterisms, 391; and the Milky Way, 167; star designations, 117; water theme, 625; zodiac and precession, 507
- Cosmology:** age of universe, 237, 347; books on, 260, 611; cosmic strings and gamma-ray bursters, 9; highest redshift, 349; new redshift cause, 587; Olbers' paradox, 458; and particle physics, 232; quantized redshifts, 454; and the Superconducting Super Collider, 588
- Dark matter:** brown-dwarf hypothesis, 139; in Milky Way, 461; in star cluster, 345
- Detectors:** Allegheny's astrometric, 360; the CCD, 238; gravitational wave, 364
- Eclipses:**  
**Lunar:** October 7, 1987, penumbral, 399  
**Solar:** March 29, 1987, annular-total, 102; September 23, 1987, annular, 172; prospects for March 18, 1988, 21, 342
- Education:** Halley experiment on Kuiper Airborne Observatory, 303; high-school astronomers, 192; *The Infinite Voyage*, 463; International Space University, 231; *Novae*, 349; Project STAR, 452; *The Ring of Truth*, 349; Space Camp, 153; students for space, 658; textbook review, 487
- Galaxies:** IC 1619, 459; M31, 559; M33, 140; M51, 559; M61, 138; M74, 137; M101, 138; NGC 404, 682; NGC 891, 682; NGC 2681, 136; NGC 2841, 137; NGC 3521, 138; NGC 3808, 459; NGC 4258, 137; NGC 5248, 136; NGC 6672, 220; NGC 6675, 220; NGC 6685, 220; NGC 6695, 220; NGC 6713, 220; NGC 6822, 331; NGC 6902, 443; NGC 6912, 444; NGC 7172, 444; NGC 7331, 441
- Active:** hydrogen disk around Markarian 348 (NGC 262), 9; and quasar formation, 577
- Clusters of:** and Bootes Void, 232; Coma's globular clusters, 346; around NGC 68 and NGC 80, 683; Virgo cluster age, 578
- Interacting:** NGC 4013's warped disk, 576; NGC 6776's hexagonal shape, 120; polar-ring, 459
- Local Group (see also Milky Way and Magellanic clouds):** black hole at M31's center, 10; details of M33, 140; discovering M31's structure, 595; NGC 6822, 331
- Milky Way:** center, 349; dark matter, 461; structure, 167; wide-angle photo, 16
- "Normal":** core of M87, 13; Malin 1, 123; origin of spiral structure, 136; young dwarf Haro 2, 122
- Superclusters of:** and the "Great Attractor," 119
- Gamma-ray astronomy:** coded-aperture imaging, 126; extragalactic bursters, 9
- Gravitation:** fifth force, 349; gravitational waves, 364; satellite to measure, 460; 300th anniversary of Newton's *Principia*, 18
- H I regions:** disk around Malin 1, 123; extensive disk around Markarian 348 (NGC 262), 9; warped disk of NGC 4013, 576
- H II regions:** 461; M33, 140; Orion, 455
- Herbig-Haro objects:** Horsehead nebula, 253
- History:** ancient view the Milky Way, 167; E. E. Barnard and dark nebulae, 30, 253; Cape Town's time ball, 117; discovering M31's spirals, 595; first Palomar Sky Survey, 128; Jean Foucault, 358; Horsehead discovery, 253; mapping southern sky, 243; meteor woodcut, 252; 17th-century celestial mechanics, 6; 300th anniversary of Newton's *Principia*, 18; Ursid meteors, 678; Venus' clouds, 350; views of Lagoon nebula, 106; zodiac, 507
- Image processing:** the CCD, 238; improving astrophotographs, 326
- Infrared astronomy:** Cygnus Loop, 233; icy nebula, 346; Pluto, 248; quasars and active galaxies, 577; Venus, 350
- Interferometry:** Fourier tachometer for helioseismology, 476; with infrared telescopes, 575
- Intergalactic matter:** quasars and hydrogen clouds, 125, 235
- Interplanetary matter:** diamond formation, 349
- Interstellar matter:** deuterium abundance, 236; diamond formation, 349; and the heliosphere, 578; quasars and hydrogen clouds, 121
- Light pollution:** city observing, 35; at Kitt Peak, 237; at Palomar, 237
- Magellanic Clouds:** nova in LMC, 581; and SN 1987A, 15, 16, 217
- Masers:** methanol emission, 119
- Meteorites:** amino acids, 233; cause of noctilucent clouds, 7; locating using radar, 10; prehistoric impact evidence, 12, 13, 125; Tunguska, 459
- Meteors:** catalogue, 184; counting, 678; intense showers, 658; parent of Epsilon Geminids, 237; woodcut of 1833 Leonids, 252; Ursids, 678
- Millimeter and submillimeter astronomy:** Pico Veleta telescope, 120; telescope in Chile, 463
- Molecular clouds:** Orion, 455; phosphorus in, 463
- Molecules:** amino acids in meteorites, 233; deuterium abundance, 236; hydrocarbons in Comet Halley, 13; methanol masers, 119; organic matter in asteroids and comets, 343; origin of CHON, 6; of phosphorus, 463; on Pluto's surface, 248; polymer in Comet Halley, 349; Triton's surface, 462
- Moon:** astronomy from, 27; librations, 60, 63; Mare Imbrium, 55; observing Plato, 396; Straight Wall drawings, 453; tides, 526
- Nebulae:**  
**Bright:** and B stars, 147; IC 5067 (Pelican), 682; icy, 346; in M33, 140; M8 (Lagoon), 106, 466; M42 (Orion), 464; NGC 281, 682; NGC 1514, 682; NGC 2237, 682; NGC 7635, 559; North America, 560, 682; Veil, 332, 561, 682  
**Dark:** and E. E. Barnard, 30; Horsehead, 253  
**Planetary:** formation, 462; M27 (Dumbbell), 333, 560; M57 (Ring), 220, 440, 561; NGC 6543, 440; NGC 7009 (Saturn), 444; NGC 7293 (Helix), 135, 682  
**Neutrino astronomy:** solar, 470; SN 1987A, 14  
**Neutron stars:** see *Collapsed objects*  
**Novae:** in LMC, 581  
**Observatories (amateur and public):** building a portable, 87; in garage, 202; Gila, 192; Giorgio Abetti, 656; Lowell, 192; Pic du Midi, 481; Puimichel, 543  
**Observatories (professional):** Allegheny, 360; Dudley, 243; European Southern Observatory, 463, 608; fire at Palomar, 581; Keck, 575; Kuiper Airborne, 303; Leiden, 535; Lick, 373; light pollution at Palomar, 237; McDonald, 81; Pic du Midi, 481; Roque de los Muchachos, 458; Mount Wilson, 438, 581; skies at Kitt Peak, 237; Vatican, 463  
**Observing techniques:** from a city, 35; Jovian moon eclipses, 634; lunar librations, 60, 63; making sketches, 605; Martian canals, 454; meteors, 678; planetary, 370, 603  
**Occultations:** Pleiades, 284; Venus, 214  
**On-line databases and communications (see also Atlases and catalogues):** solar activity, 183  
**Optics:** Allegheny's new 30-inch objective, 360; apochromats, 317; coded-aperture imaging, 126; modeling diffraction, 294; wide-angle eyepiece, 424  
**People:** Aaronson, M., 13; Apian, P., 391; Barnard, E., 30, 253, 574; Boss, L., 243; Bradfield, W., 442, 562; de Vaucouleurs, A., 598; Foucault, J., 358; Garrard, G., 581; Gatewood, G., 360; Halley, E., 18; Honda, M., 562; Moffet, A., 576; Moore, P., 482; Morrison, P., 349; Mrkos, A., 562; Newton, L., 18; Owendon, M., 234; Peimbert, M., 13; Peltier, L., 562; Roberts, I., 253, 595; Rubbia, C., 13; Sagdeev, R., 13; Sevcny, A., 13; Shu, F., 13; Souther, B., 667; Stromgren, B., 348; Thaddeus, P., 13; Tinsley, B., 261; Weber, J., 364; Zeigler, K., 192  
**Photography:** comet-tracking camera, 428; finding M31's shape, 595; improving by copying, 327; index to S&T deep-sky photographs, 117; Konica 3200-speed color film, 558; measuring with a wire micrometer, 310; Palomar Sky Surveys, 128; "toothless" camera mount, 546  
**Physics:** fifth force, 349; gravitational waves, 364; new redshift cause, 237; particle overview, 582, 609; with the Superconducting Super Collider, 588; strange matter, 580; of white dwarfs, 132  
**Planetary:** defending Digistar, 118; projectors, 279; in Spain, 84  
**Planets and their satellites:** Planet X, 237; satellites as captured asteroids, 349  
**Earth (see also Moon):** core temperature, 345; measuring mountains, 121, 581; ocean tides, 526; swallowed by red-giant Sun, 575  
**Jupiter:** Great Red Spot, 513; satellite eclipses, 634  
**Mars:** canals, 454; contaminating, 228; tornadoes, 579; water, 237  
**Neptune:** 235; Triton's surface chemistry, 462  
**Pluto:** 248, 574, 581  
**Saturn:** age of rings, 13  
**Uranus:** changing orbit, 182; rings, 231  
**Venus:** 350  
**Pulsars:** see *Collapsed objects*  
**Quasars:** 151, 457; binary, 237; and hydrogen clouds, 121, 125, 235; most distant, 349; origin, 457, 577  
**Relativity:** gravitation-testing satellite, 460  
**Science policy:** SDI and astronomy, 340; Soviet astro-physics plans, 601  
**Solar system:** comets in Oort cloud, 459; edge of heliosphere, 578; long-term stability of planetary orbits, 182; Sun and center of gravity of, 363  
**Space-based astronomy:** effects from *Challenger*, 29; gamma-ray telescope, 126; Kvant module, 599; no



evidence for Planet X, 237; with Voyagers 1 and 2, 456

**Spacecraft:** Galileo, 463; gravitation probe, 460; Mars Observer delay, 13; measuring mountains, 121, 581; Mir, 580, 599; obtaining orbital elements of, 118; Pioneer 9 lost, 7; Pioneers 10 and 11, 237; solar observatory, 463; Space Shuttle schedule, 581; space telescope power problems, 7; storing satellites in space, 11; Ulysses launch set, 347, 581; Voyagers 1 and 2, 456

**Space debris:** French-ring debate, 4, 453

**Space policy:** American-Soviet pact, 11; China's space station, 125; Japan's space shuttle, 125; NASA's goals, 23, 228, 349; Space Shuttle schedule, 581

#### Star clusters:

**Associations:** O stars, 464

**Globular:** in Coma galaxy cluster, 346; M13, 438, 561; M30, 444; M56, 220; M72, 444; M73, 444; millisecond pulsar in M28, 125; missing mass, 345; pulsar in M4, 581

**Stars:** B stars, 147; extrasolar planets, 125, 360; faint and brown dwarfs, 139, 461; formation regions, 461; molecular clouds around, 455; O stars, 464; seismology, 475; solar comparisons, 142; stellar granulation, 247; strange stars, 580; white dwarfs, 132, 147, 347; Wolf-Rayet, 464

**Double and multiple:** Beta Lyrae's evolution, 354; binary frequency, 8, 573; computing a binary's orbit, 71; VB 8B's disappearance, 139

**Individual:** Mira, 636; oscillations of Alpha Centauri and Alpha Canis Minoris, 475; Pleione's disappearing gas shell, 125; possible companions around Epsilon Eridani and Gamma Cephei, 125; Vega, 219

**Variable:** books on, 374, CX and CY Aquarii, 398; German observers, 84; HU Tauri, 512

**Sun:** 142; activity updates, 183; corona heating, 231; granulation, 247; green flash, 680; helioseismology, 470; magnetism, 343; new satellite telescope for, 463; oscillations, 470; as red giant, 575

**Sundials:** modern Stonehenge, 83; on walls, 646

**Supernovae:** automatic searches, 229, 230; Cassiopeia A fragments, 124; Cygnus Loop in infrared, 233;

frequency, 460; media coverage of SN 1987A, 116; SN 1984E progenitor, 234; SN 1987A, 14, 16, 125, 217, 258, 342, 349, 453, 477, 599

**Telescope making:** apochromatic lenses, 317; better star diagonal, 668; big binoculars, 593; blackening a tube, 548; boatbuilder's observatory dome, 664; cartop mount, 593; the CAT, 484; cleaning optics, 118, 573; clip-on altaz sensor, 590; comet-seeking scope, 594; comet-tracking camera, 428; computer-driven scopes, 591; easing polar alignment, 594; Foucault's innovations, 358; grinding a 42-inch mirror, 543; lensless finder, 591; motorized observing chair, 665; off-axis guider, 590; open tube baffle, 590; pinhole supplier, 317; pitch lap, 593; Poncet mounting, 200; protecting mounts, 668; rechargeable hand warmers, 602; reducing vibrations in a mounting, 314; regulating a DC motor, 198; seized disks, 317; shaft encoders, 317; simple tripod, 426; telescope flashlight, 90; "toothless" camera mount, 546; top 10 ideas, 590; wire micrometer, 310

**Telescopes (amateur):** Buchroeder's 10-inch, 371; French's 10-inch, 370; 42-inch at Puimichel, 543

**Telescopes (professional):** helioseismology, 470; MMT's diffraction limit, 236; portable infrared, 575; radio and infrared in India, 12; Royal Greenwich Observatory instruments, 537; 30-inch refractor at Allegheny, 360; Foucault's 80-cm reflector, 358; 48-inch Palomar Schmidt, 128; 60-inch Mount Wilson, 438; 1.8-meter Vatican, 463; 100-inch Hooker, 581; 4.2-meter William Herschel Telescope, 237, 458; 6-meter in Soviet Union, 140; 10-meter Keck on Mauna Kea, 575; 15-meter NTT on Mauna Kea, 8; 15-meter submillimeter telescope in Chile, 463; 30-meter millimeter telescope in Spain, 120; 250-foot Jodrell Bank renamed, 237

**Timekeeping:** Cape Town time ball, 117; leap second, 581

**Ultraviolet astronomy:** SN 1987A, 477; with Voyager spacecraft, 456

**Very-large-scale structure:** Bootes void, 232; Great Attractor, 119

**X-ray astronomy:** with Kvant module, 599; Sun, 142

## Your computer can make an astronomical difference.

With almost any personal computer, a modem, and a subscription to CompuServe, you can link up with thousands of other astronomy enthusiasts through CompuServe's new Astronomy Forum by simply making a local phone call. You can get answers from the experts, leave messages for other members, have real-time conferences, and even download free non-commercial software right online.

Call or write to receive a free Inquiry brochure or to order a Subscription Kit direct. If you're already a CompuServe subscriber, type GO ASTRONOMY at any prompt to join the Astronomy Forum.

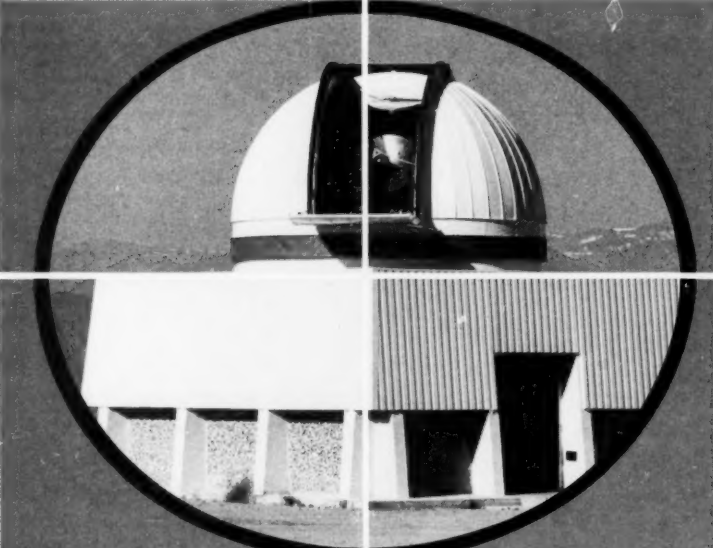
**800-848-8199**

In Ohio or outside the continental United States, call 614-457-0802.

Write to: CompuServe Inquiry Brochure  
Dept. MA1017  
P.O. Box 20212  
Columbus, Ohio 43220

**CompuServe**

An H&R Block Company



Ash Domes have been recognized internationally by major astronomical research groups, universities, colleges, secondary and primary schools for their performance, durability and dependability. Mechanical or electrical dome and shutter drives in sizes from ten to 36 feet in diameter; sensibly priced.

Brochures and specifications available.

**ASH MANUFACTURING COMPANY • INC.**  
BOX 312 PLAINFIELD • ILLINOIS • 60544 • AC-815 438-9403

## FOCUS ON COLUMBIA UNIVERSITY MILLIMETER-WAVE SKY SURVEY PROJECT Cerro Tololo Inter-American Observatory, Chile

The 48-inch millimeter-wave telescope was installed at Cerro Tololo Inter-American Observatory and saw first light in December of 1982.

Its large-scale survey observations of molecular clouds in the southern sky have already revealed much new information on Milky Way structure and on the makeup of our nearest galactic neighbors, the Magellanic Clouds.

The photo taken at 2,200 meters elevation at Cerro Tololo shows the specially made wide-slit dome, the surface of the telescope dish, the building, and snow remaining on mountains in the Dona Ana range, with peaks to 6,000 meters.

Photo by Joe Montani

